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Applicant: CAMPBELL, John Ross

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We now submit the certified copy of the priority document in respect of the above patent application.

Submitted by,



Anthony Asquith  
(Regn 32373)

Agent for the Applicant

Encl:

Certified Copy (CA-2,314,763) ✓

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Specification and Drawings, as originally filed, with Application for Patent Serial No:  
2,314,763, on July 28, 2000, by **JOHN ROSS CAMPBELL**, for "Laminated glass panels".

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**Abstract of the Disclosure****Title: LAMINATED GLASS PANELS**

Decorative panels are manufactured by cutting out profiled shaped-pieces, using a numerically-controlled water-jet cutting machine. The shaped-pieces are picked from the cutting table by hand, and placed in the apertures of a pre-cut template, positioned on a base-pane. Colouring and texturing may be included. The base-pane, together with the shaped-pieces located thereon by the template, are placed in a furnace, and heated to fusing temperatures.

Anthony Asquith  
Agent for the Applicant  
Docket: 821-11

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1 Title: LAMINATED GLASS PANELS

2  
3  
4 This invention relates to the production of decorative glass  
5 panels, in which the decoration takes the form of shaped glass  
6 pieces laminated upon, and adhering to, a base-pane of glass.  
7 Contributing to the decorative effect, the shaped-pieces may  
8 be coloured or textured.  
9

10  
11 BACKGROUND TO THE INVENTION

12  
13 The invention is concerned with panels in which cut-out shapes  
14 of glass are laminated to a base pane. Such panels are known  
15 in the prior art, in which the cut-out pieces are cut out by  
16 hand. The hand-cutting techniques include the traditional  
17 score-and-crack method, to produce a straight-line, or almost  
18 straight-line, break; and the traditional "nibbling" technique  
19 to produce curves. While it is not impossible to produce  
20 concave curves by nibbling, practically the process has been  
21 limited to convex curves.  
22

23 Hitherto, the shaped-pieces have been cut out basically on a  
24 handicraft basis. That is to say, the pieces are cut by hand,  
25 and the quality of the cut is highly dependent upon the skill  
26 and care of the craftsperson doing the cutting. As a result,  
27 a good decorative panel, which includes several cut-out  
28 shaped-pieces, takes a long time to make; if the panels are  
29 used as (identical) door panels in a set of kitchen cabinets,  
30 for example, the set of panels can be very expensive.  
31

32 Another difficulty is that the shaped-pieces had better be cut  
33 from the same piece of glass as the base-pane to which the  
34 shaped-pieces are to be adhered. The shaped-pieces are  
35 adhered to the base-pane by placing the base-pane, with the  
36 shaped-pieces laid thereupon, into a kiln or furnace. The  
37 heat causes the surface of the glass items to melt, and the  
38 pieces then fuse together. If the shaped-pieces have a  
39 different characteristic or coefficient of  
40 expansion/contraction, for example, from that of the base-  
41 pane, the decorative panel might be liable to crack as it

1 cools. The traditional handicraft-system requires that the  
2 initial sheet of glass, i.e the sheet from which both the  
3 base-pane and the shaped-pieces are to be cut, must be quite  
4 large. Breakages will inevitably occur when making the  
5 shaped-pieces, especially if the pieces are elaborately or  
6 intricately shaped, and therefore a breakage allowance is  
7 needed.

8  
9 With hand-cutting, the shaped-piece is not cut directly from  
10 the initial sheet. Rather, a small manageable section has to  
11 be cut from the large initial sheet, and then the detailed  
12 work is carried out on the small section. The small section  
13 is cut by score-and-crack, and score-and-crack cuts must  
14 extend right across, from edge to edge of the glass. Thus,  
15 even more allowance is needed, for cutting the small sections  
16 from which the final shaped-pieces will be cut. With the  
17 wastage and other allowances that must be made, clustering the  
18 shaped-pieces on the initial sheet for commercial economy can  
19 be difficult.

20  
21 It is possible for batches of glass to be closely controlled,  
22 during manufacture, as to the uniformness of the  
23 characteristics of the glass, batch to batch, whereby the  
24 shaped-pieces need not be cut from the same initial sheet as  
25 the base-pane; but glass made to such all-the-same-properties  
26 standards is expensive.

27  
28 Despite the difficulties and the expense, an artistically-  
29 designed coloured-glass panel can be very attractive indeed,  
30 and the effect of a set of them, e.g a set of, say, ten  
31 kitchen-cabinet doors, is stunning.

32  
33 With the aim of simplifying the manufacture of the panels,  
34 some glass suppliers have offered the all-the-same-properties  
35 pieces on a pre-cut basis, done in artistic shapes such as  
36 flower petals etc. These pre-cut pieces have been supplied  
37 already coloured.

38  
39 The invention is aimed at making it possible for decorative  
40 glass panels to be manufactured on a mass-production basis,  
41 rather than on a handicrafts basis, and especially to do so

1 without resorting to (expensive) uniform-properties glass.

2

3

4 GENERAL FEATURES OF THE INVENTION

5

6 The invention lies in a procedure for manufacturing decorative  
7 glass panels, of the kind having a base-pane, and having one  
8 or more shaped-pieces that lie flat upon, and are fused to,  
9 the base pane.

10

11 The glass panels are manufactured according to the following  
12 procedure.

13

14 The shaped-pieces are cut from an initial-sheet of glass in a  
15 numerically-controlled glass-cutting machine. The machine has  
16 the following operational characteristics: that a sheet of  
17 glass is placed in the path of a cutting-head, and the  
18 cutting-head is operable to cut right through the sheet of  
19 glass; that the arrangement of the machine is such that the  
20 cutting-head follows a profile laterally with respect to the  
21 sheet of glass; and the profile followed by the cutting-head  
22 relative to the sheet of glass is numerically programmable.

23

24 The invention also involves providing a template, having a  
25 plurality of apertures, the apertures respectively  
26 corresponding to the cut shapes of the shaped-pieces.

27

28 The shaped-pieces are removed from the cutting table of the  
29 cutting machine, and are placed in the apertures of the  
30 template.

31

32 When the shaped-pieces are in the positions and orientations  
33 on the base-pane as determined by the apertures of the  
34 template, the assembly is placed in a furnace.

35

36 Taking care to ensure that the shaped-pieces are not disturbed  
37 from their positions, the assembly of the base-pane and the  
38 shaped-pieces are heated together in the furnace, whereby the  
39 shaped-pieces become fused to the base-pane.

40

41 Finally, after cooling, the decorative panel comprising the

1 base-pane with the shaped-pieces fused thereto, is removed  
2 from the furnace.

3  
4 In the invention, preferably the shaped-pieces are laid in the  
5 apertures of the template manually; that is to say, by direct  
6 manipulation, with the hands and fingers, of a person.

7  
8 Preferably, once the shaped-pieces have been cut, and the  
9 template has been prepared, the template is placed directly on  
10 the base-pane, and the template is fixed into a pre-determined  
11 position and orientation, in the lateral sense, relative to  
12 the base-pane, in such manner that the shaped-pieces, when  
13 placed in the apertures, rest directly upon the base-pane, and  
14 are held retained in position laterally with respect to the  
15 base-pane by the presence of the template.

16  
17  
18 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

19  
20 By way of further explanation of the invention, exemplary  
21 embodiments of the invention will now be described with  
22 reference to the accompanying drawings, in which:

23  
24 Fig 1 is plan view of a decorative glass panel, in which a  
25 number of shaped-pieces have been laminated onto a base-pane  
26 in the manner of the invention.

27 Fig 2 is a side edge view of the panel of Fig 1.

28 Fig 3 is a plan-diagram of an initial-sheet of glass, showing  
29 a typical example of one of the pre-programmed profiled paths  
30 to be followed by the cutting head.

31 Fig 4 is a pictorial diagram of a water-jet glass-cutting  
32 machine, in which a cutting-head can be traversed in a pre-  
33 programmed profiled path.

34 Fig 5 is a pictorial diagram showing a base-pane, a  
35 positioning-template, and one of the shaped-pieces.

36 Fig 6 is a plan-view of a template, having apertures in which  
37 are positioned some cut shaped-pieces.

38  
39 The apparatuses shown in the accompanying drawings and  
40 described below are examples which embody the invention. It  
41 should be noted that the scope of the invention is defined by

1 the accompanying claims, and not necessarily by specific  
2 features of exemplary embodiments.

3  
4 As shown in Figs 1 and 2, the decorative glass panel 20  
5 comprises a base-pane 23 and a number of shaped-pieces 24,  
6 which are laminated onto the base-pane, by being fused, in a  
7 kiln or furnace, onto the base-pane.

8  
9 Fig 3 shows an initial-sheet 25 of glass, from which both the  
10 base-pane 23 and the shaped-pieces 24 are to be cut. The  
11 shaped-pieces 24 are to be cut on a numerically-controlled  
12 (NC) water-jet glass-cutting machine 26 (Fig 4). Such NC  
13 water-jet machines are well-known. The machines have been  
14 employed for cutting many materials, including glass.

15  
16 The line 27, which separates the base-pane 23 from the portion  
17 28 from which the pieces will be cut, may be cut by means of a  
18 conventional glass-cutter-plus-cracking technique, being a  
19 straight line, or the line 27 too may be cut with the water  
20 jet.

21  
22 The portion 28 of the initial-sheet 25 is placed on the table.  
23 The markings 29 on the portion 28 are not actually marked on  
24 the glass, but rather the numeral 29 represents the profiles  
25 or paths the cutting-head 14 of the water-jet machine will  
26 make around the portion 28.

27  
28 The cutting head is mounted on lead screws 30X,30Y, arranged  
29 as an orthogonal pair, and the machine includes a computer 32  
30 whereby the lead screws can be set so as to position the  
31 cutting head at any point over the cutting table 34. The  
32 computer 32 can be programmed to make the cutting head follow  
33 the desired pre-determined pathway or profile 29. Once  
34 programmed, of course the pathway may be repeated, or recalled  
35 at any time in the future, with basically no loss of accuracy  
36 or repeatability.

37  
38 In the water-jet process, the actual cutting of the glass is  
39 done by grains of abrasive dust, which are entrained in the  
40 water jet. The jet removes a thin slice of glass. The cut-  
41 edges of the shaped-pieces are left smooth and abraded,

1 whereby the edges are not sharp or jagged, and there are no  
2 loose slivers or other hazards. The cut pieces can be picked  
3 up in the bare hands, with very little chance of accident.  
4 (But of course, the prudent operator would wear protective  
5 gloves anyway, if only to prevent finger-marking the shaped-  
6 pieces. Fingerprints that are invisible on the cold glass can  
7 become obtrusively visible in the final panel).

8  
9 The pathway or profile 29 to be followed by the cutting-head  
10 can be simple or intricate, as determined by the programmer.  
11 The limitations as to what shapes can be done lie more in the  
12 area of ensuring that the shaped-pieces 24 are so shaped as to  
13 be chunky enough that the piece can be picked up and handled,  
14 rather than by limitations as to what shapes can actually be  
15 cut. (Traditionally, it has been the limitations of the  
16 cutting process itself that have restricted the shapes that  
17 can be cut.) With the water-jet machine, a shaped-piece  
18 would be too intricate and too fine, as to its shape, only if  
19 the shaped-piece is too fragile to be handled. The designer  
20 should have it in mind not to go too far in the direction of  
21 delicacy and intricacy of the shaped-pieces; although such  
22 pieces can be cut with the water-jet machine, and the pieces  
23 would survive the cutting process, the pieces might be too  
24 fragile to be handled.

25  
26 It may be noted that, in the water-jet cutting machine, the  
27 glass does not need to be held down tightly while cutting  
28 proceeds. The water jet produces very little sideways  
29 component, so the shaped-piece has little tendency to be  
30 displaced laterally by the impact of the water jet.

31  
32 After the water-jet cutting is complete, the cut shaped-pieces  
33 24 now reside on the cutting-table 34 of the cutting-machine,  
34 each shaped-piece still in the as-cut positional relationship  
35 relative to the other shaped-pieces. The initial-sheet 25, or  
36 rather the portion 28 of the initial-sheet, remains as a  
37 matrix in which the several shaped-pieces remain located.

38  
39 The several cut-out shaped-pieces 24 are now transferred from  
40 the cutting-table 34 of the water-jet cutting-machine, onto  
41 the base-pane 23. This aspect of the procedure is assisted by

1 the use of a template.

2  
3 Fig 5 shows a template 35, having apertures 36. The template  
4 is used for locating the shaped-pieces 24 into their correct  
5 positions and orientations on the base-pane 23. The operator  
6 first places the base-pane 23 flat on a platform or table 37,  
7 and then places the template 35 over the base-pane.

8  
9 Next, the operator aligns the template 35 to the base-pane 23.  
10 The alignment can be achieved by, for example, making the  
11 template to the same overall (rectangular) dimensions as the  
12 base-pane, whereby alignment consists simply of aligning the  
13 sides of the rectangles together. Or, the template may be  
14 brought into alignment by aligning the template to marks that  
15 have been made on the base-pane. Or, bearing in mind that the  
16 base-pane is made of transparent glass, marks can be drawn on  
17 the table 37 underneath the base-pane, and the operator aligns  
18 the template to the marks that s/he can see through the base-  
19 pane, having previously aligned the base-pane to other marks  
20 on the table 37. The base-pane 23 (or the template 35) may be  
21 sprayed with an adhesive, to make sure the template stays in  
22 place.

23  
24 Alternatively, exact alignment of the template on the base-  
25 pane may be left until all the shaped-pieces have been placed  
26 in the respective apertures.

27  
28 The apertures 36 in the template 35 have to be larger than the  
29 shaped-pieces 24. That is to say, a margin of clearance 38  
30 (Fig 6) must be present, in the respective aperture 36, all  
31 around the shaped-piece 24, to ensure that the shaped-piece  
32 can actually be inserted into its respective aperture in the  
33 template. It would not be acceptable for the apertures 36 to  
34 be cut size-on-size with the nominal outline of the shaped-  
35 pieces 24, because then the shaped-pieces would be too tight  
36 in the apertures, and there would be no margin for errors of  
37 cutting -- i.e errors of cutting either the shaped-pieces or  
38 the apertures.

39  
40 But because the shaped-pieces 24 have been cut so accurately,  
41 by the operation of the NC water-jet machine, the margin of

1 clearance between the apertures 36 in the template 35 and the  
2 shaped-pieces need be only minimal. Cutting the apertures  
3 with a clearance margin of about 1 milli-metre, all around the  
4 respective shaped-pieces 24, may be expected to give all the  
5 clearance that might be needed. If the shaped-pieces 24 are  
6 small, and chunky in shape, the clearance margin may be even  
7 less than that.

8  
9 Although the numerically-controlled pre-programmed water-jet  
10 cutting-machine 26 is very accurate and very repeatable, of  
11 course there is still some variation and error by which the  
12 cut-pieces 24 differ slightly from the programmed profile.  
13 The increased accuracy means the errors are made smaller, not  
14 that they are eliminated. The template apertures must be cut  
15 so that the margin of clearance 38 is large enough to allow  
16 for the worst accumulation of errors that might be present in  
17 any one of a production run of the shaped-pieces. A shaped-  
18 piece that will not fit its aperture, because its cutting  
19 errors are too much, will have to be rejected. The aperture  
20 should be cut with a large enough margin of clearance, with  
21 respect to the nominal profile of the shaped-piece, that none,  
22 or very few, of the cut shaped-pieces have to be rejected.

23  
24 If the cutting process were not very accurate, and if the  
25 template apertures were cut with only a small margin of  
26 clearance, many or most of the cut shaped-pieces would have to  
27 be rejected. Either that, or the margin of clearance would  
28 have to be made larger. But the problem with making the  
29 margin of clearance larger is that now the pieces that are cut  
30 more closely to the nominal profile, or a little smaller,  
31 would start to become very loose in the template apertures,  
32 and not be located properly in position on the base-pane, by  
33 the fit of the shaped-piece in the aperture.

34  
35 Thus there is a compromise: the margin of clearance should not  
36 be too small, whereby all but a few of the cut shaped-pieces  
37 have to be rejected; but the margin of clearance should not be  
38 too large, whereby the shaped-pieces that are cut exactly to  
39 the nominal profile, and smaller, are so loose in the  
40 apertures as to be not located properly.

1 It is recognised that this compromise between making the  
2 margin of clearance too small or too large is eased, the more  
3 accurately the shaped-pieces can be cut always to conform  
4 exactly to the nominal pre-programmed profile.

5  
6 It is recognised that the traditional handicrafts techniques  
7 for cutting the shaped-pieces to a pre-determined profile were  
8 so inaccurate that the use of a template to locate the shaped-  
9 pieces in position on the base-pane would have been  
10 substantially pointless. The use of a template technique to  
11 locate hand-cut shaped-pieces on the base-pane, really would  
12 have involved making a fresh template for each panel. The  
13 craftsperson might as well make up the design by laying the  
14 pieces straight onto the base-pane -- which is indeed how  
15 decorative panels have been manufactured, traditionally.

16  
17 It is further recognised that, when the NC water-jet cutting  
18 technique is used to cut out the shaped-pieces, now the  
19 shaped-pieces conform so closely and repeatably to the nominal  
20 pre-determined profile, that the margin of clearance can be  
21 small. It is recognised that the margin of clearance can now  
22 be small enough that those shaped-pieces that happen to have  
23 no accumulated errors, or to have accumulated errors that make  
24 them smaller than the nominal profile, now are still close  
25 enough to the sides of the apertures as to still be well-  
26 located, by the apertures, as to position and orientation  
27 relative to the other shaped-pieces and to the base-pane.

28  
29 It is recognised, in the invention, that the use of a template  
30 does not simplify matters when the shaped-pieces are cut by  
31 hand; but that a template will be highly useful for  
32 simplifying the task of locating the shaped-pieces in position  
33 on the base-pane, when the shaped-pieces are cut by NC  
34 machine.

35  
36 Now that the shaped-pieces are cut to such close conformance  
37 to the nominal profile, the operator now does not have to  
38 select the pieces to fit the aperture. The operator can pick  
39 the cut shaped-piece, put it in the aperture, and move  
40 straight on to the next piece. The absence of the need to  
41 select and fit each shaped-piece means that the template

1 technique is suitable for mass production of the decorative  
2 panels. The operator can be relatively unskilled, i.e s/he no  
3 longer need be an artist or a craftsman. Measured in terms  
4 of the monetary cost of labour for manufacturing a set of  
5 identical decorative panels, the difference between the craft  
6 approach and the NC-cutting-plus-template approach is  
7 enormous.

8  
9 It might be considered that it would be advantageous for the  
10 cut shaped-pieces to be picked from the cutting machine table,  
11 and placed on the base-pane, by an automatic pick-and-place  
12 apparatus. However, it is recognised that this would not be  
13 economical. Of course, automatic pick-and-place apparatus are  
14 well-known, in which a picking head is brought down into  
15 contact with a work-piece, and the work-piece is attached to  
16 the head, for example by means of vacuum suction. Then the  
17 head moves automatically, e.g under the control of a  
18 programmed computer, to a new location, where the piece is set  
19 down. In that case, there would be no need for templates, in  
20 that the shaped-pieces would be located in place by the  
21 programming of the pick-and-place apparatus. The use of a  
22 pick-and-place apparatus means there would be no need for an  
23 operator at all, to do the picking and placing.

24  
25 This would be outside the present invention. The invention  
26 requires the combination of the accurate cutting of the  
27 profiles of the shaped-pieces (which results from NC cutting),  
28 and the use of an apertured template to assist the manual, i.e  
29 human, operation of then placing the cut shaped-pieces exactly  
30 at the desired position and orientation on the base-panel.

31  
32 It is recognised, in the invention: (a) that templates do not  
33 contribute anything when the shaped-pieces are not cut  
34 accurately; and (b) that templates do not contribute anything  
35 when the shaped-pieces are picked and placed by automatic  
36 machine; but (c) that an appropriately-apertured template  
37 simplifies the manual task, by a human operator, of picking  
38 and placing the shaped-pieces, given that the shaped-pieces  
39 have been cut accurately by NC machine.

40  
41 Some types of shapes of the shaped-pieces 24 tend to

1 accumulate errors more than other shapes, during the water-jet  
2 cutting process. For example, the slight tendency of the  
3 water-jet process to deflect a cut piece laterally, small as  
4 that tendency is, is greater with a long thin shape than with  
5 a short chunky shape. The designer may therefore elect to  
6 provide a larger margin of clearance around some areas of the  
7 profile of the shaped-piece than around others, on the grounds  
8 that the errors are likely to be greater in those areas.

9  
10 Also, the layout of the design itself may require more  
11 accuracy of placement in some areas than in others. In a  
12 design of a flower, for example, in which long thin petals or  
13 leaves radiate from a central core, it is probably more  
14 important that the radially-inner ends of the radiating pieces  
15 be more accurately positioned and aligned than the radially  
16 distant ends of those pieces. This difference in importance  
17 of alignment can be reflected in the difference in the size of  
18 the margin of clearance between the inner ends and the outer  
19 ends of the petal-pieces.

20  
21 The apertures in the template preferably should be cut in a NC  
22 machine.

23  
24 Generally, the shaped-pieces will not be aligned to the same  
25 position and orientation when placed on the base-pane as they  
26 were on the table of the water-jet glass-cutting machine.  
27 However, the profile of the shaped-piece, as an isolated  
28 profile, can be derived from the NC program used in the glass-  
29 cutting machine, and the program for that profile can serve as  
30 the basis for preparing the program for the profile of the  
31 respective aperture to be cut in the template. It is simple  
32 enough, with an NC cutting system, to program a margin of a  
33 certain width all around an already-programmed nominal shape.

34  
35 Some shapes require a larger margin of clearance than other  
36 shapes. It is suggested that the margin of clearance, i.e the  
37 width of the margin between the nominal (i.e as-programmed)  
38 profile of the shaped-piece and the nominal profile of the  
39 aperture should be not less than about half a milli-metre wide  
40 if the shaped-piece is small and chunky, and not less than  
41 about one milli-metre if the shaped-piece is long and thin.

1 The clearance margin of a shaped-piece at a location where it  
2 is not so critical to the design may be left greater than the  
3 clearance margin around a shaped-piece of a similar size and  
4 shape, but which is more critically located.

5  
6 Also, as mentioned, it is not a requirement that the margin of  
7 clearance be the same all around the shaped-piece.

8  
9 Also, sometimes, if the designer wishes, the margin of  
10 clearance may be larger than is strictly needed from the  
11 standpoint of catering for errors in the cutting process. It  
12 is not difficult for an experienced programmer to modify the  
13 width of the margin, so the margin at one end of the piece is  
14 larger than the margin at the other end of the piece, if so  
15 desired (or allowed) by the designer of the decorative panel.  
16 The extra margin of clearance might be used to assist the  
17 operator in expending minimum time on the task of placing the  
18 shaped-piece in the aperture; but apart from that, there will  
19 usually be no point in allowing more margin than is needed to  
20 accommodate whatever (small) errors arise from the cutting  
21 process.

22  
23 In some designs, the designer might elect to place two of the  
24 shaped-pieces in edge-to-edge abutment. In that case, the  
25 aperture in the template would be cut to accommodate the two  
26 shaped-pieces side by side. Of course, if the pieces are side  
27 by side, usually the designer will simply specify that the  
28 pieces are cut, not as two, but as one piece. However,  
29 sometimes, the designer might desire the extra line-definition  
30 that arises from actually separating the pieces. It is noted  
31 that cutting a template aperture to accommodate two shaped-  
32 pieces (or more than two) in edge-to-edge abutment, is hardly  
33 more difficult than cutting an aperture to accommodate just  
34 one shaped-piece.

35  
36 As mentioned, it is not a requirement that the aperture margin  
37 be the same all around the shaped-piece. It is not a  
38 requirement that the wall of the aperture even be present, as  
39 a continuous wall, all around the shaped-piece. A shaped-  
40 piece can be perfectly well-located on the base-pane, even  
41 though the walls of the aperture abut the shaped-piece only

1 over small, but strategically-placed, areas.

2  
3 On the other hand, it is preferred that the aperture 36 should  
4 have a close visual resemblance to the shaped-piece 24 that is  
5 to fit therein, to make the task of placing the shaped-piece  
6 in the correct aperture a little easier.

7  
8 The pieces to be laid together in one aperture need not have  
9 been cut together, in the same orientational and positional  
10 relationship on the table of the cutting machine as they have  
11 on the base-panel in the final design. For cutting, it can be  
12 arranged that the left side of one piece is cut by the same  
13 pass of the cutting head that cuts the right side of the  
14 adjacent piece. If the pieces share the same cut, then of  
15 course a convex curve on the piece to the left becomes a  
16 concave curve on the piece to the right; if the design permits  
17 or requires that, it can be done. Pieces cut like that may or  
18 may not be placed together in a single aperture of the  
19 template.

20  
21 The shaped-pieces adhere to the base-pane, by fusing, when the  
22 glass pieces are brought to a temperature of around 1300  
23 deg-F. Glass has the property, at this temperature, that the  
24 surfaces of the pieces fuse (i.e melt) just enough to run  
25 together, whereby the pieces, upon cooling, are integrated  
26 together.

27  
28 It is not essential that the base-panel remain flat during  
29 firing of the assembled decorative panel. The panel may be  
30 placed on a dished mould (known as a sagger) and the heat is  
31 enough to cause the base-pane, together with the shaped-pieces  
32 resting thereon, to sag down into the mould.

33  
34 The template may be secured in place on the base-pane with  
35 adhesive, and left in place during firing. Leaving the  
36 template in place ensures the shaped-pieces do not move during  
37 transfer of the base-pane and the assembled shaped-pieces from  
38 the assembly table onto the shelf of the furnace. The  
39 template (and the adhesive holding the template to the base-  
40 pane, if present) should be of a material that will combust,  
41 and will disappear completely, at the glass-fusing

1 temperature. The template may be made of thin card ( $\frac{1}{2}$ mm),  
2 thick card, fibre-board, plywood, thin sheet plastic, thick  
3 polystyrene (10mm), etc.

4

5 In the invention, it is preferred that the template be cut out  
6 by an NC cutting process -- not necessarily the water-jet  
7 cutting apparatus, though that can be used. However, the NC-  
8 cutting of a template is much slower than, say, stamping the  
9 templates out. If the production run of a particular design  
10 warrants it, the designer might prefer to cut out a stamping  
11 tool, for stamping out large numbers of the same template,  
12 rather than cut out the individual templates.

13

14 It is not essential that the templates be destroyed. In a  
15 case where the template is to be re-used, the template may be  
16 made of metal. Generally, the economics of manufacturing  
17 small batches of decorative panels is such that the best  
18 economy comes from cutting the templates, in cardboard or  
19 polystyrene, one for each panel, by a pre-programmed NC  
20 cutter.

21

22 Colour is applied to decorative glass panels by applying the  
23 colouring materials between the base-pane and the shaped-  
24 pieces. During firing, as the pieces become fused to the  
25 base-pane, the colouring material is vitrified, and fixed into  
26 the panel. The colouring that is to show through the shaped-  
27 pieces may be applied as a flat area of colour, in the  
28 simplest form, or the colouring may be applied as an elaborate  
29 design in itself, and may include marked lines, differently-  
30 coloured areas, textures, and all the rest of the large  
31 variety of effects that can be achieved in decorative glass.  
32 The glass used for the decorative panels may be grained or  
33 textured, as manufactured, or may have some colouring already  
34 included, and the designer may blend the design into the as-  
35 manufactured characteristics of the glass.

36

37 The present invention is aimed at enabling the manufacture of  
38 the decorative panels to be (partially) automated, in the  
39 manner as described herein. Accordingly, it is preferred not  
40 to draw or paint a design onto the base-panel, or onto the  
41 shaped-pieces, on a crafts basis, but rather to pre-prepare

1 the design in a reproducible manner, whereby the design can be  
2 applied to the base-pane by a relatively unskilled person.

3

4 To this end, the design may be pre-applied to a plastic  
5 transfer sheet, by a suitable batch printing process, from  
6 which the design is then transferred to the base-pane (or to  
7 the shaped-pieces). This is done before the shaped-pieces are  
8 located on the base-pane, and before the template is applied  
9 to the base-pane.

10

11 Special colouring-templates may be employed, in which spray  
12 colouring matter, frits, etc, may be applied, by spraying,  
13 pasting, sprinkling, brushing, etc, through the apertures in  
14 the colouring-templates. The apertures for the colouring  
15 matter should complement, but need not correspond to, the  
16 apertures in the template that hold the shaped-pieces in  
17 position.

18

19 The colouring materials may be applied by spraying or rolling  
20 the materials onto the shaped-pieces. The designer might  
21 prefer to arrange that batches of the shaped-pieces be  
22 coloured together, prior to being placed in the templates. A  
23 colouring station may be established, which is arranged for  
24 rapid application of colour, and for easy changeover between  
25 colours. For example, at the colouring station, the batch of  
26 pieces being worked on may be arranged on mesh, for example,  
27 so that the surplus colouring material drains away easily.

28

29 The invention may be applied even when the decorative design  
30 comprises just one single shaped-piece, to be laid on the  
31 base-pane. However, the invention is most advantageous when  
32 there are many shaped-pieces. Now, the need for a template  
33 which locates the shaped-pieces on the base-pane, accurately  
34 to a particular positional and orientational relationship to  
35 each other, becomes more acute. Basically, the more pieces,  
36 the greater the need for accuracy in their relative locations.  
37 When the shaped-pieces were cut by hand, if a template were  
38 used to position the pieces, the template would have to be  
39 five mm, or more, clear around the nominal profile of the  
40 shaped-piece. No designer could accept positioning accuracy  
41 like that.

1 The invention is aimed at bringing a degree of semi-automation  
2 to the process of manufacturing decorative glass panels. It  
3 is recognised that full automation, which would include  
4 automatic picking of the shaped-pieces, and automatic placing  
5 of same on the base-pane, is not appropriate for the type of  
6 small batch production which characterises the manufacture of  
7 decorative glass panels. It is recognised that the pick-and-  
8 place aspect of the manufacturing operation is best done  
9 manually -- provided the operator has a template to simplify  
10 the task of placing the shaped-pieces on the base-pane. It is  
11 recognised that the template can only be useful if the shaped-  
12 pieces are cut very accurately, and it is recognised that they  
13 can be cut accurately enough on a NC cutting machine, and a  
14 water-jet machine is preferred because the cut pieces can be  
15 handled straight from the cutting machine.

16  
17 Because much of the design is pre-prepared, and production  
18 involves simply reproducing the design, attention can be given  
19 to quality, both of the manufacturing itself, and of such  
20 operations as packaging (which is important in a glass  
21 product). Furthermore, the fact that the design is pre-  
22 programmed means that a broken panel can be replaced, even on  
23 a one-off basis. The design is simply called up again, from  
24 the computer, and the shaped-pieces, the templates, and the  
25 rest, can be remade.

26  
27 The system of the invention is especially suited to small  
28 batches, but can be applied to larger production runs also.  
29 Thus, the system is highly suitable for decorative glass  
30 panels, where a designer wishes to offer a number of standard  
31 designs, as well as the facility for custom designs. With the  
32 invention, the only extra cost of the custom design lies in  
33 the time for the artist to make the design, and for the  
34 programmer to translate that to an NC program. Once that is  
35 done, the custom design passes through the production system  
36 exactly as does a standard design. Therefore, custom designs  
37 can be done to the same in-factory quality as standard  
38 designs, and are not hugely more expensive.

39  
40 It is recognised that some types of automation are worth  
41 doing, others not. It is recognised that the automation

---

1 system described herein allows an interaction between operator  
2 and automatic machine that is highly appropriate to the  
3 production of decorative glass panels. On the one hand, it  
4 would be difficult to amortize the cost of full automation,  
5 but on the other hand, the traditional not-at-all-automated  
6 crafts approach is very expensive, yet still quality can be  
7 poor. It is recognised, in the invention, that it is possible  
8 to move to a level of automation technology that can be  
9 amortized over the kinds of selling prices and quantities that  
10 will be made and sold, in the field of decorative glass  
11 panels.

12

13 The use of the invention also permits glass to be used more  
14 economically, in that hand cutting, even by a skilled  
15 craftsperson, gives far more breakages than a NC water-jet  
16 cutting machine. Therefore, also, it is possible to plan to  
17 make larger designs from a single sheet of glass.

18

19 The invention is also aimed at permitting savings on the  
20 inventory side. When the pieces were cut by hand, from the  
21 same sheet as each other and the base-pane, there was a  
22 problem of storing the cut pieces in such a way as to ensure  
23 retrieving and matching of the pieces from the same initial  
24 sheet. With the invention, there is hardly any need at all  
25 for work-in-progress inventory. The pieces are cut, placed on  
26 the base-pane, and inserted into the furnace, basically  
27 without any need for interim storage of the pieces between  
28 operations.

29

30 The invention is also aimed at making designs versatile as to  
31 fitment of the design onto differently-sized panels. For  
32 example, kitchen cabinet doors are not all the same width.  
33 Thus, the designer might wish to "fatten" a design that fits a  
34 door say 15 inches wide so as to fit doors 18" and 21" wide.  
35 It is an easy matter to have the computer increase all the  
36 left-right dimensions by a suitable factor. The factor can be  
37 applied to the shaped-pieces, the templates, etc, as required.

38

39 Generally, the NC water-jet cutting machine will be located in  
40 a different factory from the furnace. The table at which the  
41 panels are made up, prior to being placed in the furnace,

1 should be located adjacent to the furnace, and arrangements  
2 made so that the assembled design of shaped-pieces resting on  
3 the base-pane can be transferred into the furnace without  
4 being disturbed. After cutting, the shaped-pieces should be  
5 removed from the table of the cutting machine, with  
6 appropriate precautions to prevent damage to the shaped-  
7 pieces; and also, given that the shaped-pieces will be moved,  
8 proper inventorying should be done of the shaped-pieces ready  
9 for transport and storage.

10  
11 As mentioned, it would not be appropriate for the cut shaped-  
12 pieces to be picked individually from the cutting-table by  
13 automatic machinery. However, the cut shaped-pieces may be  
14 picked from the table of the cutting machine by, for example,  
15 pressing a sheet of plastic, card, or paper, etc, coated with  
16 a press-to-stick adhesive, over the cut pieces, and picking up  
17 the sheet, with the pieces adhering thereto, and this part of  
18 the process may be automated quite simply. It is the  
19 operation of picking and placing of the individual shaped-  
20 pieces into the apertures of the template that is much more  
21 difficult to automate, and that operation preferably should be  
22 done by hand, in the invention.

23  
24 The designer may also prefer to use a backing sheet when  
25 positioning the shaped-pieces on the base-panel. In this  
26 variation, the template is used to locate the shaped-pieces  
27 into position on a backing sheet, rather than into position  
28 directly onto the base-pane. This might be preferred, for  
29 example, to enable a stock of pre-positioned shaped-pieces to  
30 be made up, and stored, for later application to the base-  
31 panes. To apply the pattern of shaped-pieces to the base-  
32 pane, the base-pane is coated with suitable adhesive, and  
33 placed on top of the pattern of shaped-pieces; the assembly is  
34 then turned over, and the backing sheet (and the template)  
35 removed. Of course, the more times the assembled pattern of  
36 shaped-pieces is handled, the more opportunities arise whereby  
37 the shaped-pieces might be displaced from their correct  
38 locations on the base-pane; the preference is, therefore, to  
39 assemble the patterns of shaped-pieces, using the templates,  
40 as described, directly upon the base-panes.

1 It is not a limitation of the invention that only one level of  
2 the cut shaped-pieces can be laid upon the base-pane. Rather  
3 than just placing shaped-pieces upon the base-pane, the  
4 designer may prefer to place shaped-pieces upon shaped-pieces,  
5 thus building up more thicknesses of glass. The decorative  
6 effect of multiple thicknesses can be quite striking, as the  
7 light catches the many edges of the pieces of glass; this is  
8 especially so in panels such as sun-catchers, which are  
9 intended to flash and sparkle with ever-changing patterns.

10  
11 In another variation, a template-positioned pattern of shaped-  
12 pieces may be sandwiched between two base-panes.

13  
14 One of the benefits of the system as described herein is that  
15 it enables the initial-sheet of glass to be used more  
16 efficiently, as to spacing of the shaped-pieces and the base-  
17 panel upon the initial sheet. Also, the fact that the glass  
18 is used more efficiently means that several more pieces can be  
19 cut from a single pane of glass, which can enable designs with  
20 many more intricate and complex shaped-pieces than has been  
21 possible hitherto.

22  
23 However, although it is preferred that the shaped-pieces be  
24 cut from the same sheet as the base-pane, and as each other,  
25 that is not essential, provided the characteristics of the  
26 glass remain compatible. The designer might prefer to use  
27 pre-coloured glass for some of the shaped-pieces. Also, the  
28 designer might prefer to use glass of different thicknesses  
29 for the shaped-pieces, for example. It may be noted that  
30 thick glass can be cut by water-jet almost as easily as thin  
31 glass: whereas hand-cutting, in practice, is limited to thin  
32 glass. The production systems as described herein make it a  
33 relatively simple matter to produce decorative panels with  
34 different thicknesses of glass, thereby giving designers the  
35 ability to create varying raised-relief effects and light-  
36 catching edge-forms.

37  
38 It should be noted that the glass used for the shaped-pieces,  
39 or for the base-panel, need not be clearly transparent, but  
40 may be translucent, or even opaque. The shaped-pieces are  
41 located into position on the base-pane by the template, and

---

1 not be a person arranging the shaped-pieces by viewing a  
2 pattern placed underneath the base-pane, for example.

3

4 Although the invention has been described as it relates to the  
5 cutting of the shaped-pieces by water jet, other cutting  
6 technologies are available, for example laser cutting. The  
7 main requirements are that the edges as cut by the cutting  
8 head should be free of sharp edges and slivers; that the  
9 cutting technology does not impose forces on the pieces that  
10 could tend to cause them to shift during cutting, as that  
11 would spoil the accuracy and repeatability of the shaped  
12 pieces; and that the cutting machine is such that the profiled  
13 path followed by the cutting head is numerically-controlled,  
14 and can be pre-programmed.

---

## Claims

**CLAIM 1.** Procedure for manufacturing decorative glass panels, wherein:

the panels comprise each a base-pane and shaped-pieces, and the shaped-pieces lie flat upon, and are fused to, the base pane;

the procedure includes:

cutting out the shaped-pieces from an initial-sheet of glass in a numerically-controlled glass-cutting machine;

the glass-cutting machine is a machine in which:

a sheet of glass is placed in the path of a cutting-head, and the cutting-head is operable to cut right through the sheet of glass;

in which the arrangement of the machine is such that the cutting-head follows a profile laterally with respect to the sheet of glass;

and the profile followed by the cutting-head relative to the sheet of glass is numerically programmable;

providing a template, having apertures, and the apertures correspond to the cut shapes of the shaped-pieces;

positioning the shaped-pieces on the base-pane, using the apertures in the template to locate the pieces in position thereon;

placing, in a furnace, the base-pane with the shaped-pieces resting thereon in the positions and orientations thereon as set by the apertures in the template;

ensuring that the shaped-pieces do not become disturbed, in the furnace, from their set positions and orientations on the base-pane;

heating the base-pane and the shaped-pieces together in the furnace, whereby the shaped-pieces become fused to the base-pane, and withdrawing the panel comprising the base-pane with the shaped-pieces fused thereto, after cooling, from the furnace.

**Claim 2.** Procedure of claim 1, wherein the cutting-head of the glass-cutting machine includes a water-jet, of such nature as to cut right through the sheet of glass.

**Claim 3.** Procedure of claim 1, wherein the apertures in the

template are cut out on an NC machine.

**Claim 4.** Procedure of claim 3, wherein the procedure includes cutting the apertures in the template in a template cutting machine, in which the cutting-head follows a profile laterally with respect to the template, and the profile followed by the cutting-head relative to the template is numerically programmable.

**Claim 5.** Procedure of claim 1, including providing a coatings-template, placing the same over the base-pane; and applying colouring material onto the base-pane, through apertures in the coating-template.

**Claim 6.** Procedure of claim 1, wherein the operations of picking the shaped-pieces from the cutting machine, and placing the shaped-pieces in the apertures of the template on the base-pane, are carried out manually, by a human operator.

**Claim 7.** Procedure of claim 3, wherein, in respect of each aperture, the aperture is cut with a margin of clearance between the aperture and the respective shaped-piece placed in the aperture, whereby the shaped-piece is loose in the aperture, and the margin of clearance is small enough that no point on a shaped-piece cut exactly to the pre-programmed profile, and placed in the aperture, can be displaced laterally within the aperture a distance overall of no more than 3 mm.

**Claim 8.** Procedure of claim 7, wherein the shaped-piece is chunky in shape, and the shaped-piece can be displaced no more than 1 milli-metre.

**Claim 9.** Procedure of claim 1, wherein the procedure includes making the template from a combustible material, and keeping the template in place on the base-pane during firing, whereby the template is destroyed.

**Claim 10.** Apparatus of claim 1, wherein the procedure includes removing the template from the shaped-pieces and

---

from the base-pane, prior to placing the base-pane and the shaped-pieces in the furnace.

**Claim 11.** Procedure of claim 1, wherein all the shaped-pieces and the base pane are cut from the same initial-sheet of glass.

**Claim 12.** Apparatus of claim 1, wherein the procedure includes:

placing the template directly upon the base-pane, in such manner that the shaped-pieces, placed in the apertures, can rest upon the base-pane, and be held retained in position laterally with respect to the base-pane by the presence of the template;

fixing the template into a pre-determined position and orientation, in the lateral sense, relative to the base-pane;

gathering the shaped-pieces, thus cut out on the cutting machine, and placing the shaped-pieces flat upon, and in direct contact with, the base-pane, placing and orientating the shaped-pieces into their respective apertures in the template.

**Claim 12.** Apparatus of claim 1, wherein the procedure includes:

placing the template on a backing-sheet, in such manner that the shaped-pieces, placed in the apertures, can rest upon the backing-sheet, and be held retained in position laterally with respect to the backing-sheet by the presence of the template;

fixing the template into a pre-determined position and orientation, in the lateral sense, relative to the backing-sheet;

gathering the shaped-pieces, thus cut out on the cutting machine, and placing the shaped-pieces flat upon the backing-sheet, placing and orientating the shaped-pieces into their respective apertures in the template;

and transferring the backing-sheet and the shaped-pieces positioned thereon, onto the base-pane.

**Claim 13.** Apparatus of claim 12, wherein the procedural step

---

of gathering the shaped-pieces and placing the shaped-pieces flat upon the backing-sheet, and of placing and orientating the shaped-pieces into their respective apertures in the template, is carried out manually, by direct hand operation.

---

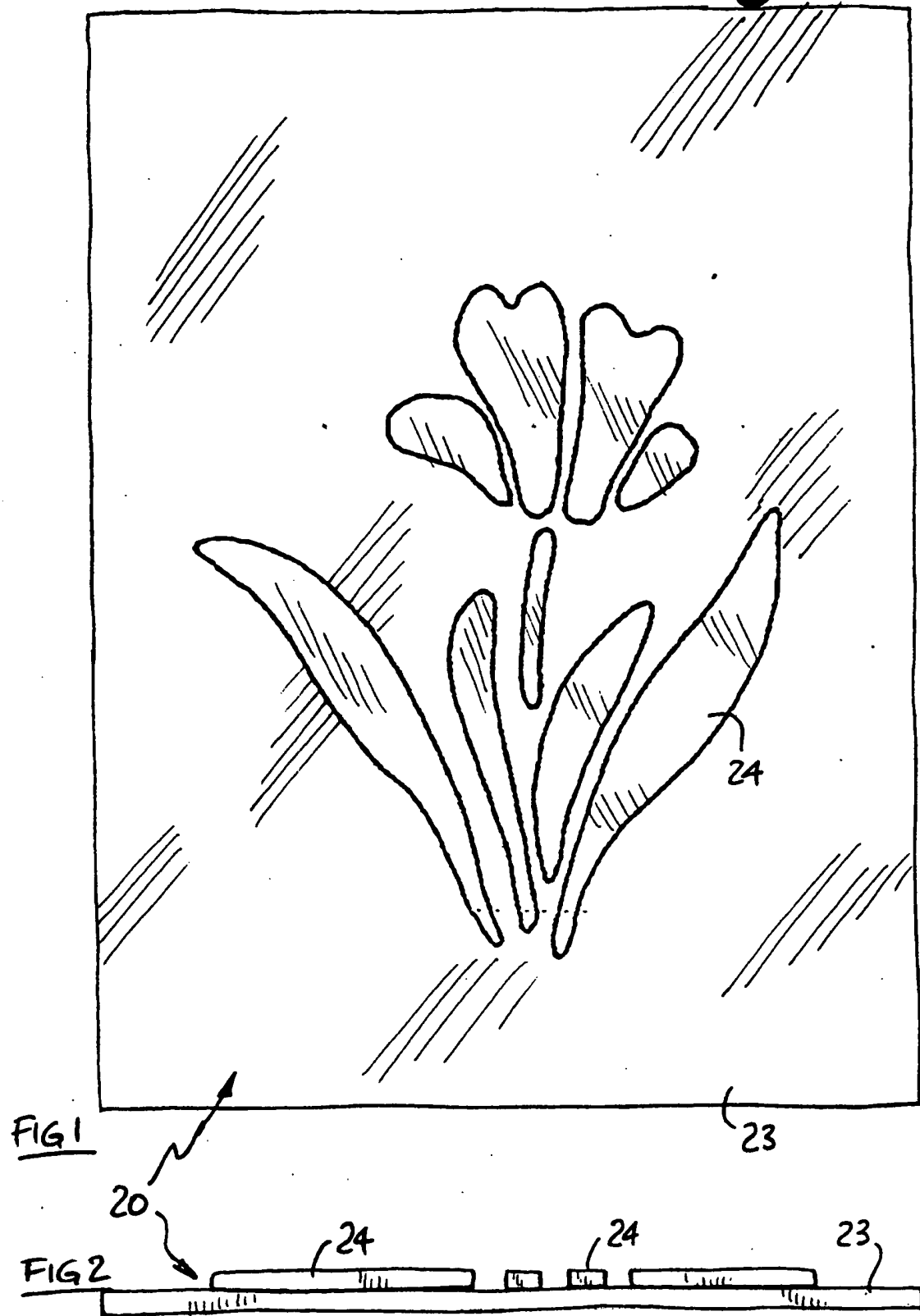




FIG 3

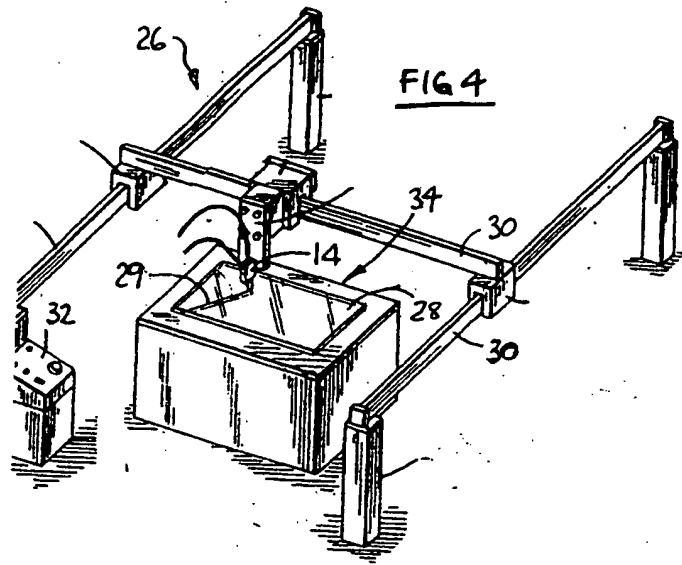


FIG 4

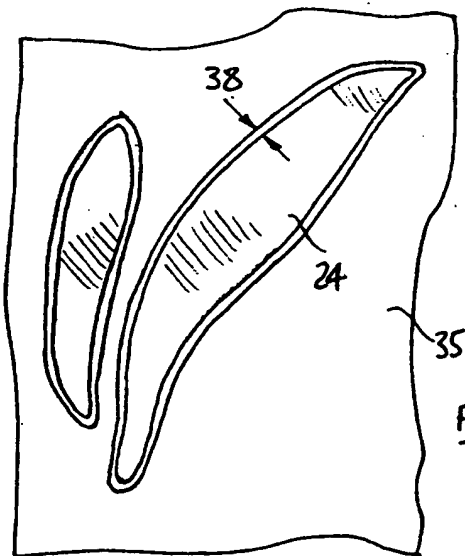


FIG 6

